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39. Proposed by SETH PRATT, C. E., Assyria, Michigan.

The pendulum of a clock which gains 6 seconds in 1 hour and 13 minute, makes 6000 vibrations in 1 hour and 9½ minutes. What is the length of the pendulum? And what length should it have to keep true time?

I. Solution by G. B. M. ZERR, A. M., Ph. D., Texarkana, Arkansas-Texas.

Regarding 1 hour, 13 minutes and 1 hour, 9½ minutes as registered by a clock keeping correct time,  $g=32.16$ ,  $\pi=3.1416$ ,  $t=\pi\sqrt{l/g}$ . Then 1 hour, 9½ minutes=4170 seconds.

$$\therefore t = \frac{4170}{\pi} = \frac{139}{200\pi} = \pi \sqrt{\frac{l}{g}} \quad \therefore l = \frac{(139)^2 g}{(200\pi)^2} = 1.57393 \text{ ft.} = 18.88716 \text{ inches.}$$

1 hour, 13 minutes=4380 seconds.

$$\frac{4380 \times 200}{139} = \text{number of vibrations in 1 hour, 13 seconds.}$$

$$\therefore \frac{4380 \times 200}{139} = 4386 \text{ seconds.}$$

$$\therefore t' = \frac{4386 \times 139}{4880 \times 200} = \frac{731 \times 139}{730 \times 200} = \pi \sqrt{\frac{l'}{g}}$$

$$\therefore l' = \frac{(731 \times 139)^2 g}{(730 \times 200\pi)^2} = 1.578243 \text{ feet.}$$

$$\therefore l' = 18.93892 \text{ inches} = \text{length to keep true time.}$$

II. Solution by E. W. MORRELL, Professor of Mathematics in Montpelier Seminary, Montpelier, Vermont.

1 hour and 9½ minutes=4170 seconds. 4170 seconds÷6000=.695 seconds, the time of one vibration. From Mechanics  $l=t^2g/\pi^2$ , whence  $l=18.886$  inches, the length of the pendulum. Again, 1 hour and 13 minutes=4380 seconds. 4380÷.695=876/.139=number of vibrations in 1 hour and 13 minutes. As the pendulum gains 6 seconds in that time,  $6 \div (876 \div .139) = .834 \div 876 = .0095$ , the time in seconds gained in one vibration.

$\therefore .695 \text{ seconds} + .0095 \text{ seconds} = .69595 \text{ seconds}$ , the time of vibrations of pendulum to keep correct time. Hence by substitutions in the above formula  $l=18.9379$  inches, the length of pendulum to keep true time.

[NOTE.—The results sent in with the problem by the Proposer were, 18.89835+ inches, and for true time .036036+ inches longer. Prof. P. S. Berg in his solution obtained for length of pendulum 18.837975 inches, and 22.393 inches as the length to keep true time. ERROR.]

## PROBLEMS.

49. Proposed by J. SCHEFFER, A. M., Hagerstown, Maryland.

Give a general proof that the centre of gravity, or centroid, determines that point from which the sum of the distances to all other points of a given area is the minimum.